INFRABEL

TS 50729
Battery trains

Eress Workshop

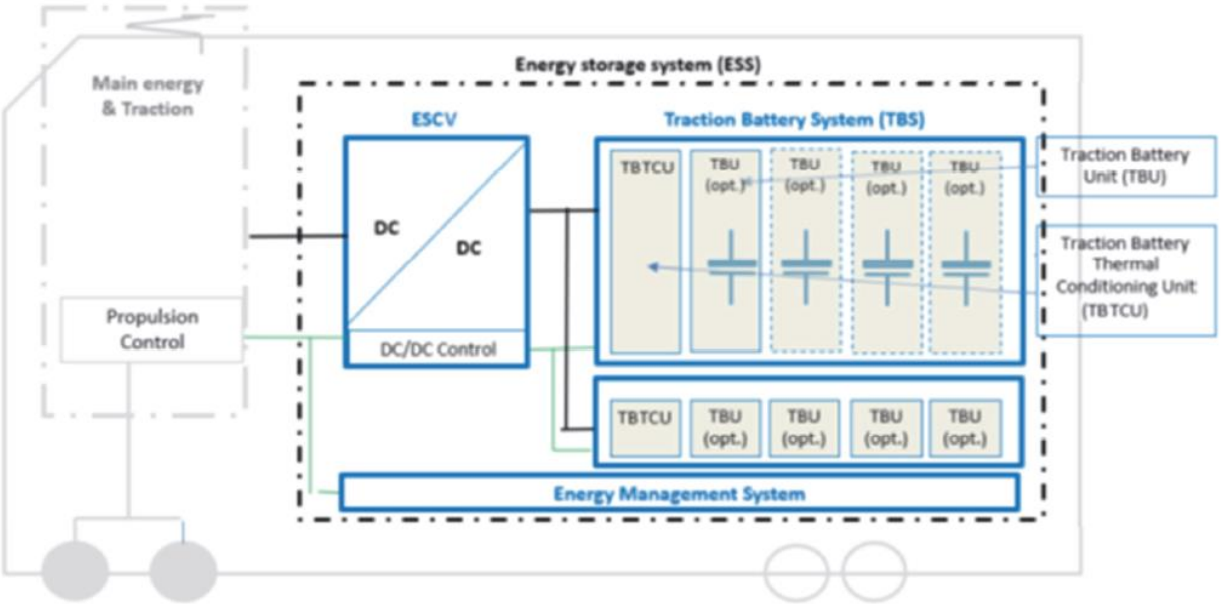
Bart Van der Spiegel

24 November 2023

Regional passenger traffic in France

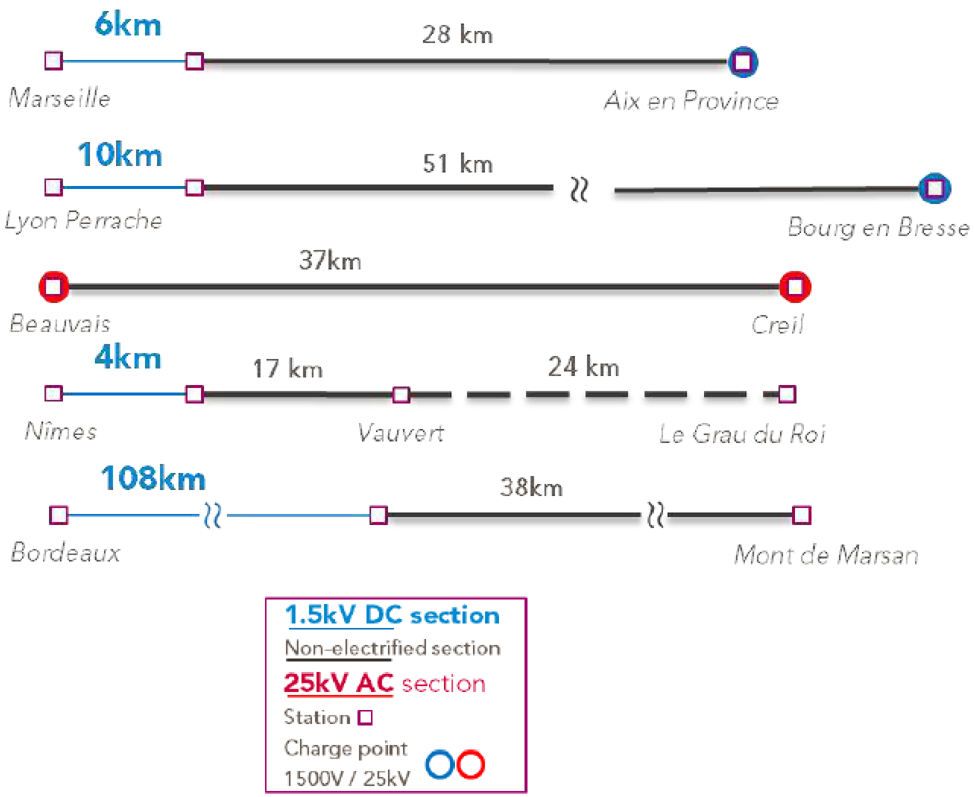
SNCF Voyageurs schedules midlife revision of more recent 3-vehicle DMUs for regional traffic and will create BEMUs out of them.

- Energy Storage System: 2x210 kWh (2x420 kWh train level)
- Peak power charging: 640 kW
- Peak power discharging : 800 kW
- Energy savings: up to 20% (enabling regenerative braking)
- Less noise, less maintenance costs



Source: Luis Alonso and Heinz Flerlage, ICT for Railways, 15th and 16th November 2023

Regional passenger traffic in France



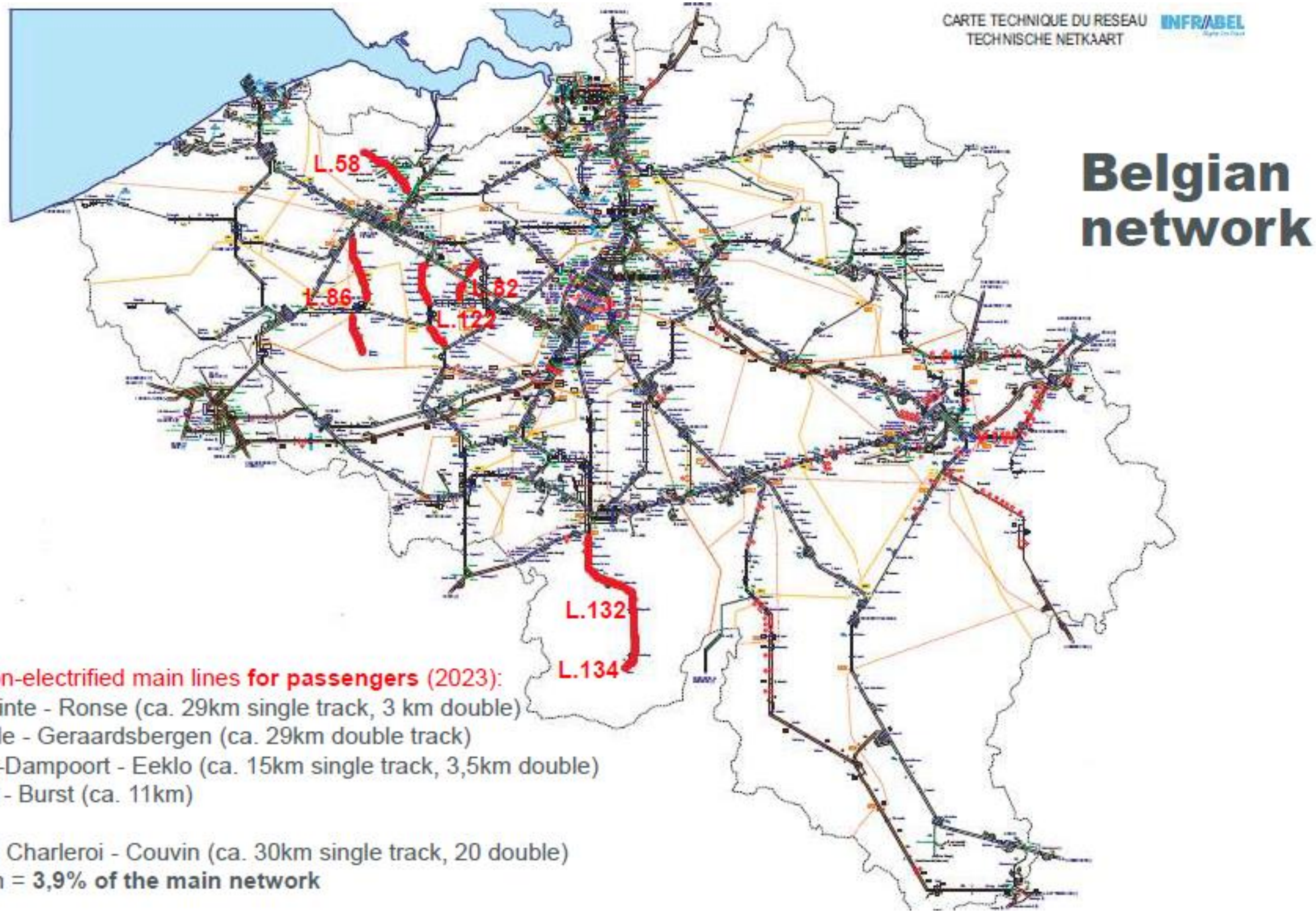
Source: Luis Alonso and Heinz Flerlage, ICT for Railways, 15th and 16th November 2023

Study from lessor federation

- More than 50 % of locomotives in EU are still using diesel traction.
- Investors require lessors to phase-out diesel traction.
- Study made by Eolus: see website of AERRL.
- HVO (hydrotreated vegetable oil) is a possible bridge solution.
- For heavy freight green hydrogen is best solution (but this is not yet mature).
  Hydrogen: power-electrolyser (70%)-liquefaction (70%)-transport (90%)-evaporation (95%) => Overall 40%
  + Back to power by fuel cell: overall 25%
- 85% of traffic is possible with battery/electric locomotives.
- This study recommends supporting primarily the use of Dual-Mode Battery/Electric trains combined with partial electrification for the long-term future.
- ÖBB considers partial electrification is only needed on 26% of non-electrified lines.

Source: Carole Coune, ICT for Railways, 15th and 16th November 2023

Situation in Belgium



Remaining non-electrified main lines **for passengers** (2023):

- L.86 De Pinte - Ronse (ca. 29km single track, 3 km double)
- L.122 Melle - Geraardsbergen (ca. 29km double track)
- L.58 Gent-Dampoort - Eeklo (ca. 15km single track, 3,5km double)
- L.82 Aalst - Burst (ca. 11km)

- L.132-134 Charleroi - Couvin (ca. 30km single track, 20 double)

140 / 3600 km = **3,9% of the main network**

Some bridges and tunnels don't permit electrification.

How can we accelerate this transition?

- On DC-networks charging battery trains in end stations will take too much time. It should become possible to charge higher currents.
- AC-electrifications are costly. On AC-networks cheaper charging infrastructure should become available. It should be possible to connect to medium voltage grids.
- Manufacturers should develop locomotives to be used for international freight trains. The dimensioning of the on-board energy storage will be crucial to know the partial electrification needs in ports and industrial areas.
- Battery trains will pass frequently to non-electrified lines. This causes risks in case pantograph is not lowered or lifted on the right moment. Solutions are needed.
- CENELEC now created a draft technical specification for the interfaces towards battery trains.

TS 50729

Aim: Supporting phase-out of diesel traction => **less CO_2 emissions for railway sector**

CENELEC TC9X – SC 9XC (Railway Applications - Fixed Installation) decided in December 2021 to install Working Group 25

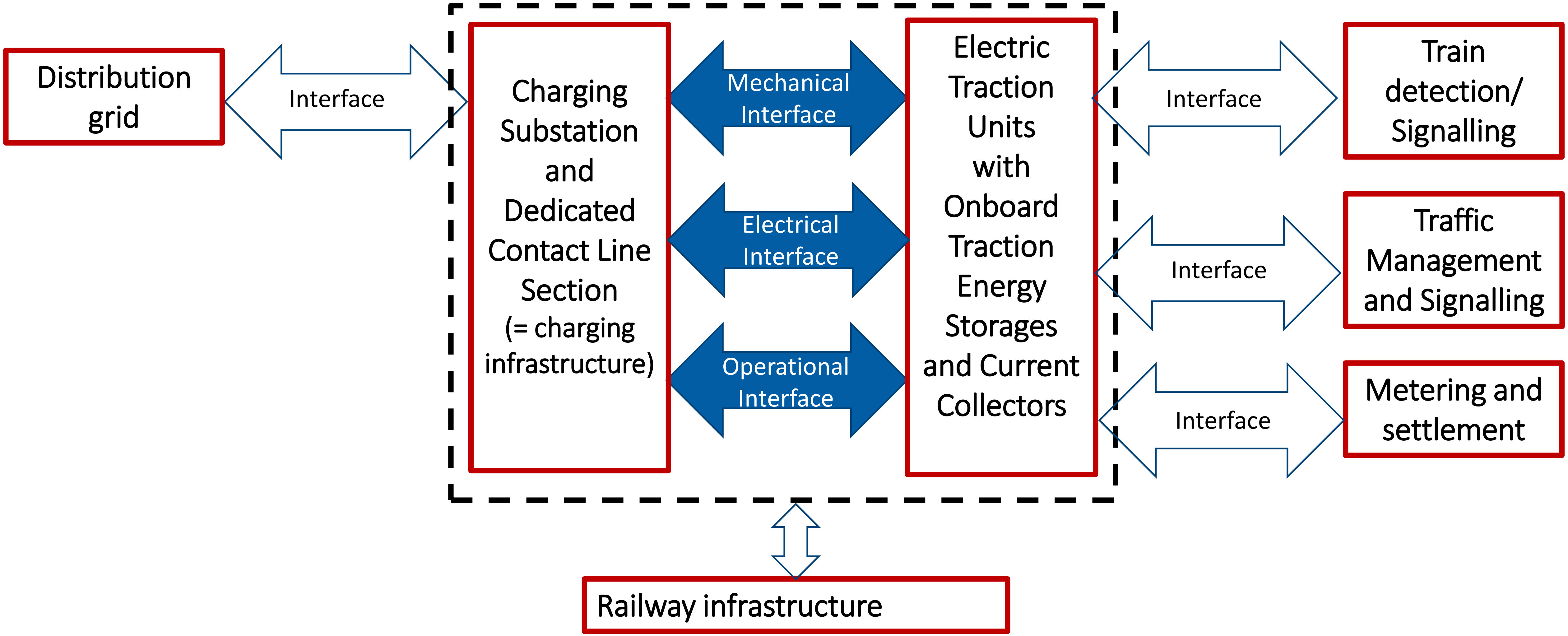
25 Members from 8 Countries:

Belgium (2), France (6), Germany (10), Italy (2), Norway (1), Sweden (1), Switzerland (2), UK (1)

Task: Development of TS 50729

- Title: Railway applications - Fixed installations and rolling stock - Interface requirements between charging infrastructure with dedicated contact line sections and electric traction units with onboard electric traction energy storages and current collectors.
- The draft (prTS 50729) is now available for review by CENELEC experts.
- **Please read our document and provide your comments before end of 2023**

Interfaces charging infrastructure <=> train



Battery train

- Basically operate on electrified railway lines
  → Electric locomotives
  → Electric multiple units
- Furthermore, equipped with onboard electric traction energy storages.
  → Can operate also on non-electrified lines.
  → Onboard electric traction energy storage feeds the traction drives and the auxiliaries.
  → able to store regenerated energy.
- Both is limited:
  → the capacity of the onboard electric traction energy storages and
  → charging time
- Frequent recharging is necessary with relatively high power.
  → Charging is carried out over the current collector.

System design / dimensioning study

Aim: to support most cost-effective solution

Coordination needed between Railway Undertakings, train builders and Infrastructure Managers on expected train offer, capabilities of traction units and dimensioning of the infrastructure.

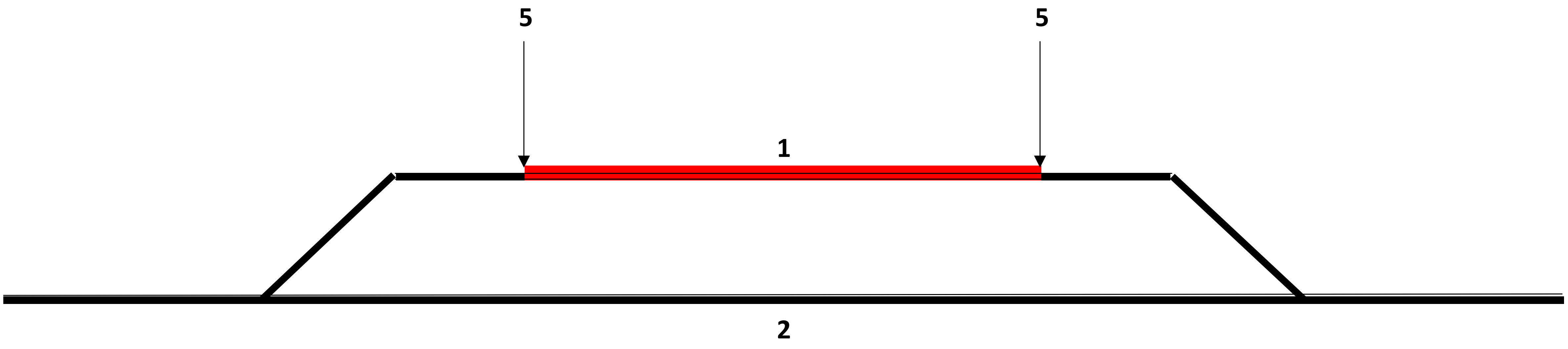
This is crucial in case of:

- limited flexibility in timetable (e.g. longer parts on single track),
- limited onboard energy storage (e.g. minimal size of battery, extended lifetime of battery) or
- weak performance of charging infrastructure (e.g. limited maximal power permitted from public grid).

October 2021 Tübingen
VOLTAP – Furrer+Frey
15/25 kV 50 Hz – 2 x 1,2 MVA
© Stadtwerke Tübingen

Charging infrastructure

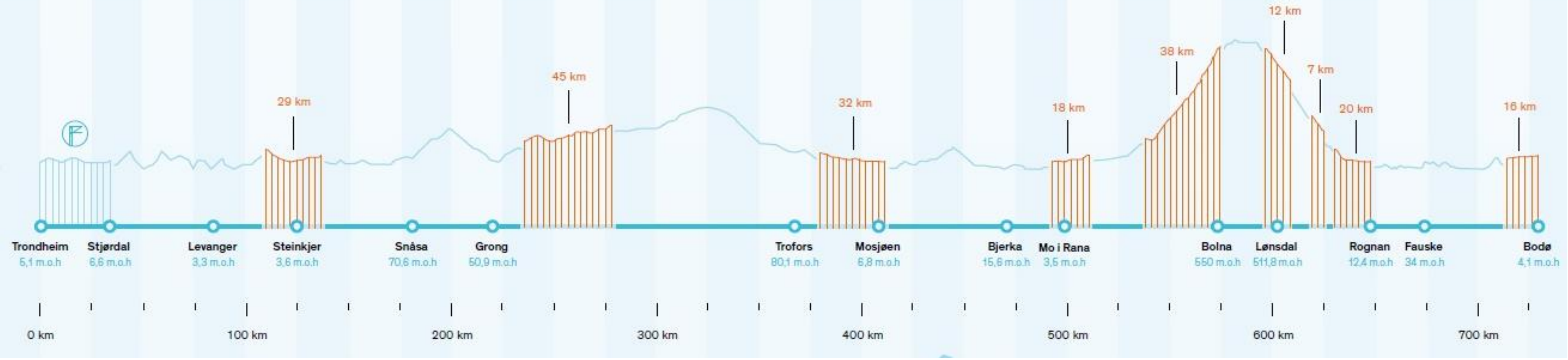
Type I: standard TSI-compliant electrification but with dedicated contact line section permitting higher currents at standstill



Key
1 - dedicated contact line section
2 - electrification system 0
5 - charging infrastructure border

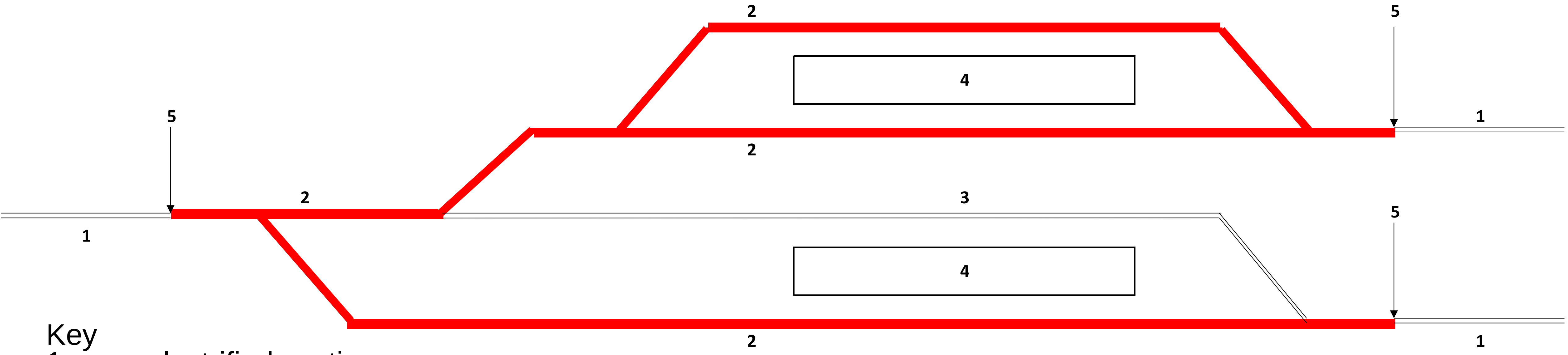
Charging infrastructure

Type II: partial TSI-compliant electrification islands (shaded areas) with longer non-electrified railway line sections (up to 100 km) in between



Charging infrastructure

Type III: non TSI-compliant electrification of a contact line island within and around a railway station (an extension of a few km is possible depending on e.g. rated power and voltage drop)

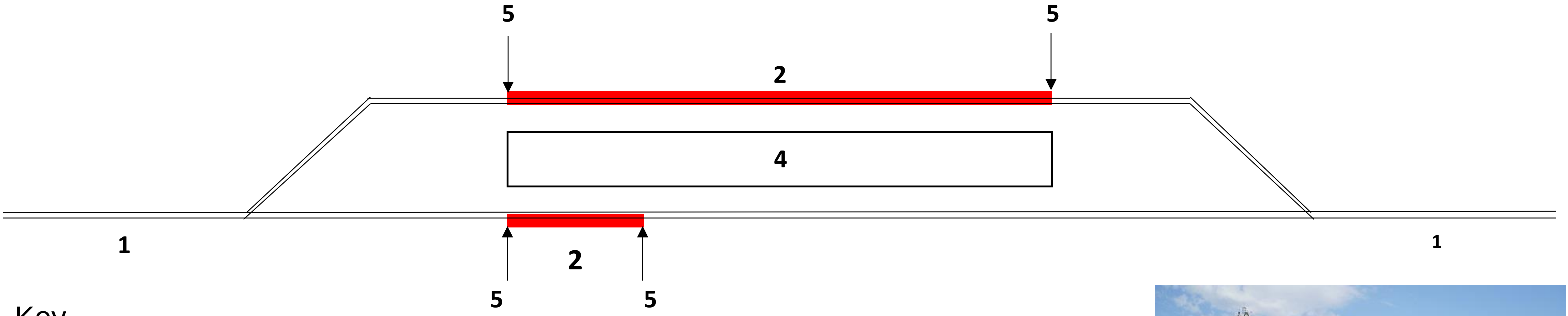


Key
1 - non electrified section
2 - dedicated contact line section
3 - non-electrified track
4 - platform
5 - charging infrastructure border

To lower costs, 15 kV 50Hz can be used for such electrification islands.

Charging infrastructure

Type IV: non TSI-compliant electrification of only a few contact line sections (only dedicated to charging at standstill)



Key
1 - non electrified section
2 - dedicated contact line section
3 - non-electrified track
4 - platform
5 - charging infrastructure border

August 2023 Annaberg
TRACFEED – RPS+F&S15/25 kV
15/25 kV 50 Hz – 3 x 1,2 MVA
© Alstom

Electrical interface

- Standards EN 50388-1, EN 50388-2, EN 50367 and EN 50633 apply.
- Voltage and frequency all requirements of EN 50163 apply.
- Charging infrastructure types III and IV:
  - → usage of a charging-system for AC 15 kV 50 Hz shall be allowed, when agreed between infrastructure manager and railway operator.
  - → Voltage limits of AC 15 kV in EN 50163, subclause 4.1 - valid independent of frequency.
  - → Frequency limits of 50 Hz in EN 50163, subclause 4.2 - valid independent of voltage.
  - → Electric traction units designed in accordance EN 50163, subclause 4.1 only, may require modifications.

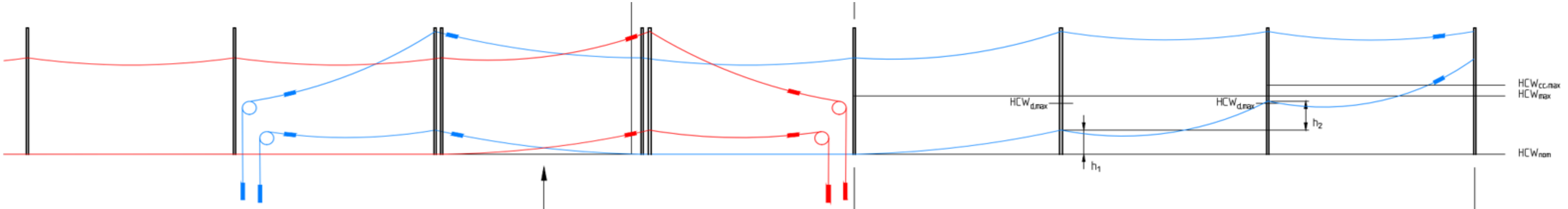
Transition from/to non-electrified lines

Transition from/to non-electrified section shall be protected (lowering and rising of pantograph on intended moment). **A risk analysis is needed to avoid**:

- drawing an electric arc while leaving electrified section,
- mechanical interference with current collector head and fading contact line,
- hitting obstacles like bridges and tunnels,
- raising too late the current collector in electrified section,
- damaging/overheating the contact line.

This can be done using:

- protection by signalling (possibly with automatic execution of signalling commands),
- neutral section connected to return circuit,
- vertical fading of contact wire and automatic lowering of pantograph at a certain level



Increase current at standstill

Current limitation is required on all electric traction units with onboard electric traction energy storages. The limitation at standstill of EN 50367 is extended to low speeds up to 10 km/h. Trains without energy storages only take limited current a low speed (to avoid slip).

Higher current offtake on dedicated contact line sections may be permitted.

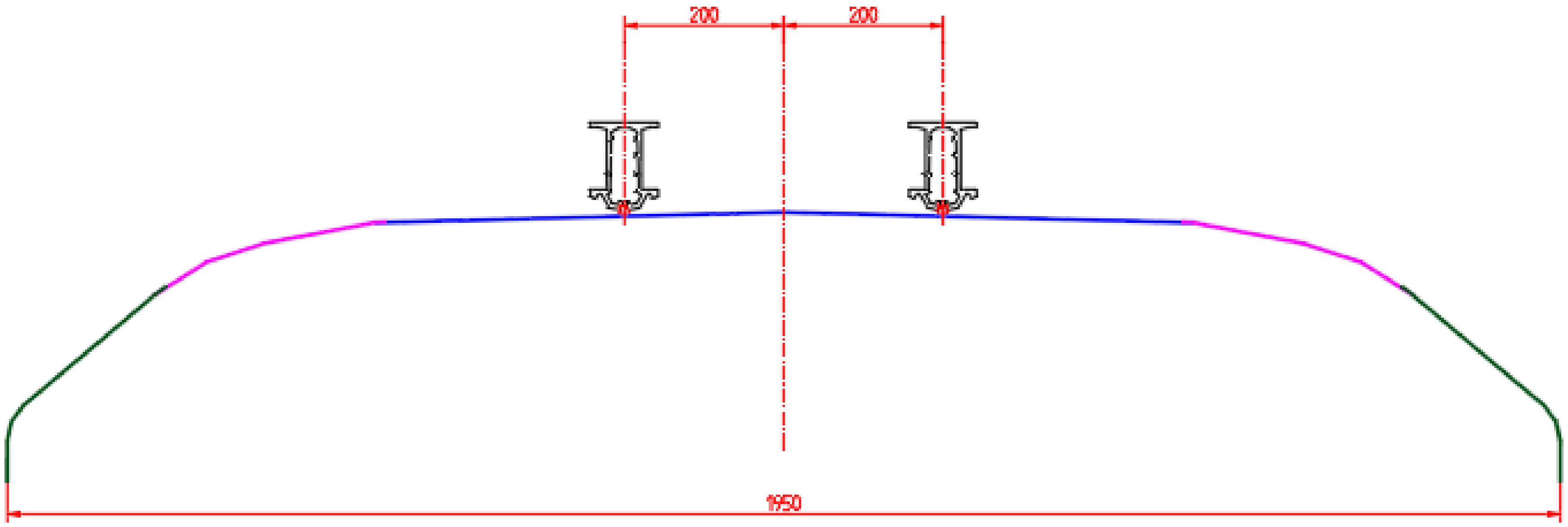
On 3 kV, on most lines 2500 A is permitted. At standstill without dedicated contact line sections only 200 A is permitted. Aim to permit e.g. 800 A on the dedicated contact line sections.

System	Current	Voltage	Charging power
DC	300 A	1 500 V	0,45 MW
	200 A	3 000 V	0,6 MW
AC	80 A	15 000 V	1,2 MVAr
		25 000 V	2,0 MVAr

Increase current at standstill

Use two overhead conductor rails (with sufficient distance on the contact with the carbon strip)

Increase static contact force at standstill



Increase current at standstill

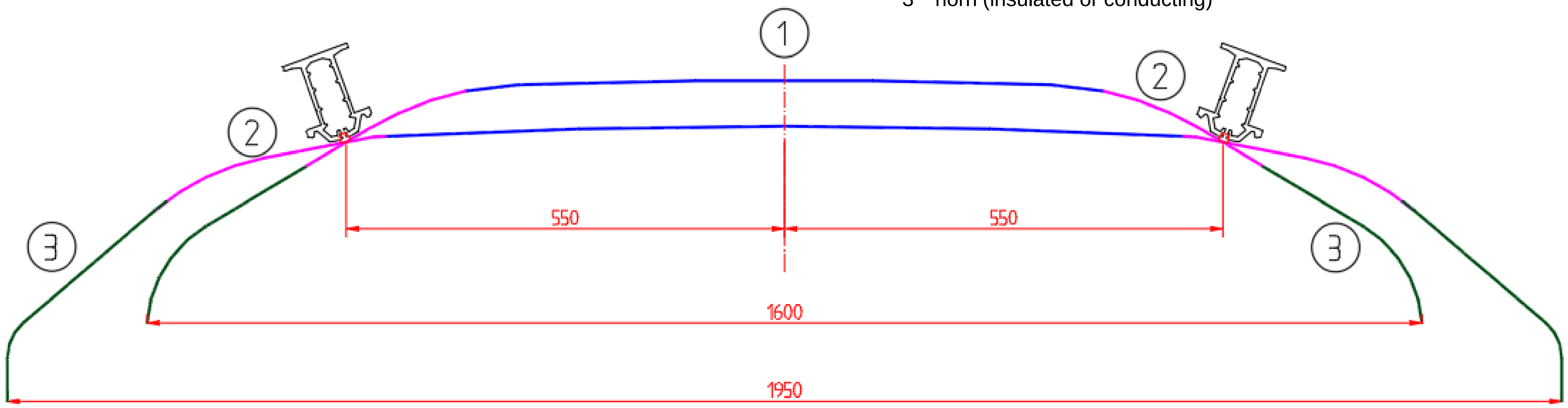
Use two overhead conductor rails with contact beyond the carbon strip on the horn layers (cupper or aluminium)

Key

1 contact strip (plain carbon or impregnated carbon)

2 part of the working zone beyond the carbon strip (part of the conducting range)

3 horn (insulated or conducting)



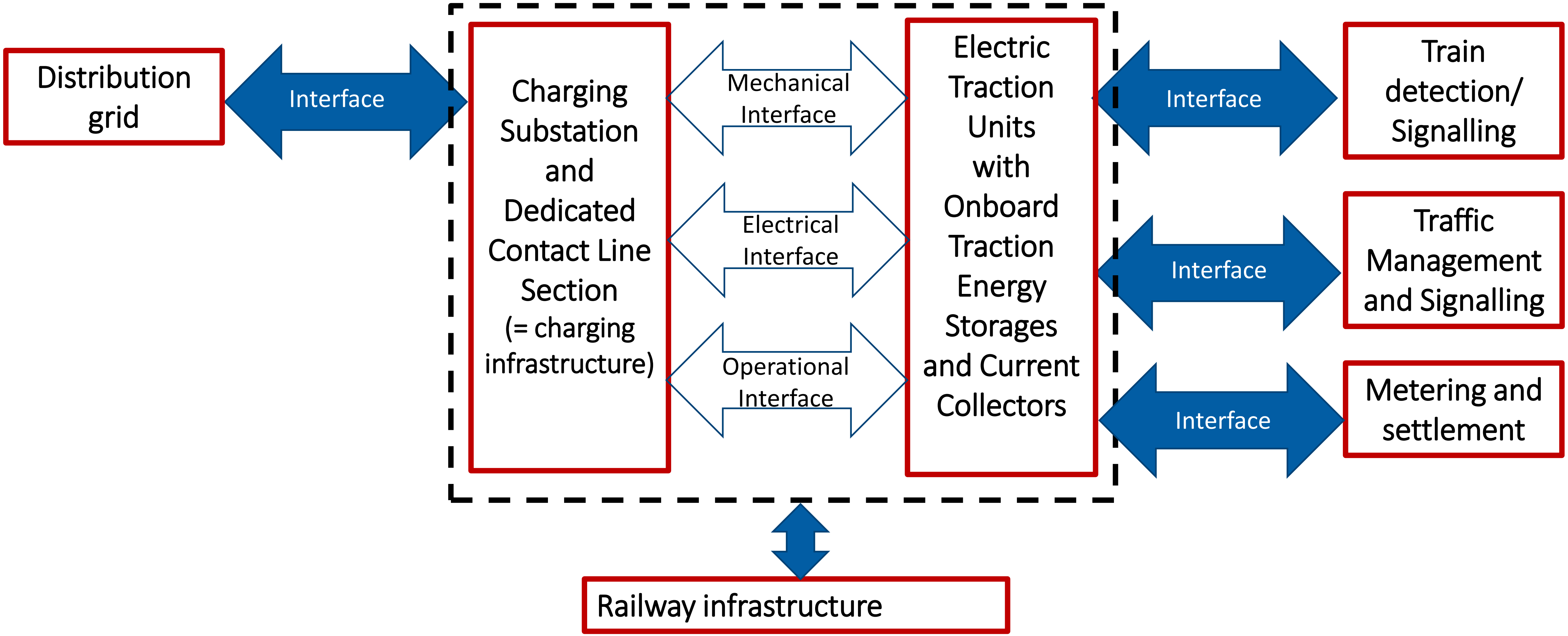
Operational interface

Information like:
- limitation of charging current,
- maximum current at standstill,
- maximum feedback current (e.g. for discharging).

shall be transmitted either:
- manually,
- automatically,
- via voltage amplitude and/or frequency,
- via communication protocol,
- or by other means

Possible interfaces:
- direct communication to Train Control & Management System,
- interface from traffic management to Automatic Train Operations or Driving Advisory Systems

Other interfaces



Other interfaces

Distribution grid: limited power, limited short circuit power, permitted harmonics, unbalance current limits, reactive power requirements.

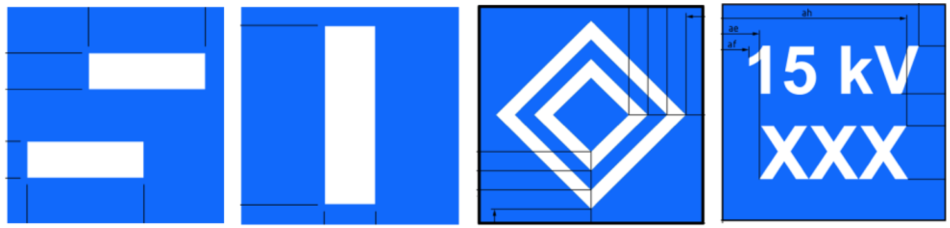
Train detection/signalling: EMC shall be ensured.

Railway infrastructure: clearance distances between electrical roof equipment and e.g. tunnels and bridges of non-electrified lines shall be respected.

Traffic management:
- optimisation of charging process might be needed and might have impact on timetable
- traffic management shall be informed on earliest departure time
- extra information can be exchanged to optimise usage of charging infrastructure

Other interfaces

Signalling of transition from/to non-electrified sections:
- rising/lowering of current collectors and switching on/off of circuit breakers
- sufficiently before entering and after leaving non-electrified section
- define needed level of automation in the risk analysis:
  - display required action and automatic execution by the TCMS
  - display required action and manual execution by the driver
  - lateral route-side signals and manual execution by the driver
  - written/vocal information and manual execution by the driver



On-board energy measurement and energy settlement:
- Energy Measurement Systems compliant to EN 50463 => all energy taken from and returned to overhead contact line shall be measured.
- all data shall be transferred to Data Collecting System on ground
- handling of data on ground is specified in IRS 90930 of UIC
- settlement shall consider higher consumptions during charging and running without consuming

Outlook

- prTS 50729 was launched for 4-month secretariat enquiry on September 19th 2023
- parallel commenting possible on SC 9XC (fixed installations - SC9XC/Sec01162/DC) and SC 9XB (rolling stock - SC9XB/Sec00877/DC)
- formal vote of FprTS 50729 expected in June 2024
- publication of TS 50729 expected end of 2024
- transfer to EN 50729 can start after first experiences in 2025 or 2026

Read the prTS 50729 and provide your comments.

Check who is registered as CENELEC expert and has access to SC 9XC or SC 9XB. Only these persons have access to the Collaboration Platform and are able to reply to the questionnaire.

Thank you for your attention.
Are there any questions?